

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification<sup>6</sup> : <b>D04H 1/42</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 95/10648</b> (43) International Publication Date: 20 April 1995 (20.04.95)</p>
<p>(21) International Application Number: PCT/US94/11732 (22) International Filing Date: 12 October 1994 (12.10.94) (30) Priority Data: 08/135,823 13 October 1993 (13.10.93) US (71) Applicant: KIMBERLY-CLARK CORPORATION [US/US]; 401 North Lake Street, Neenah, WI 54956 (US). (72) Inventors: EVERHART, Dennis, Stein; 230 Hereford Road, Alpharetta, GA 30201 (US). MEIROWITZ, Randy, Emil; 2446 Woodland Terrace, Neenah, WI 54956 (US). (74) Agents: ROBINSON, James, B. et al.; Kimberly-Clark Corpo- ration, 401 North Lake Street, Neenah, WI 54956 (US).</p>		<p>(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, ES, FI, GB, GE, HU, JP, KE, KG, KP, KR, KZ, LK, LT, LU, LV, MD, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, TJ, TT, UA, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ).</p> <p><b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>
<p>(54) Title: NONWOVEN FABRICS HAVING DURABLE WETTABILITY</p>		
<p>(57) Abstract</p> <p>There is provided a nonwoven fabric having durable wettability comprising fibers formed from polyolefin blended with hydrophilic additives of formula (I), wherein x is an integer from 1 to 15 and R is an alkane or alkene with up to 18 carbon atoms, A, B, and C are integers equal to or greater than one arranged in any order or repetitive series, z is an integer at least equal to one, and wherein the fibers which have been formed are polyolefin provided with hydrophilic additives prior to fiberization. Such fabrics have been found to provide surprisingly durable wettability.</p> <div style="text-align: center;"> <math display="block">[\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}]_A - [\text{CH}_2-\text{CH}_2-\text{O}]_x - [\text{C}-\overset{\text{O}}{\parallel}{\text{R}}]_C \quad (\text{I})</math> </div>		

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LE	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

NONWOVEN FABRICS HAVING DURABLE WETTABILITY

5

BACKGROUND OF THE INVENTION

The present invention relates to improved nonwoven fabrics or webs which are formed by extruding thermoplastic polymer filaments which can be conveyed onto a "forming wire" and bonded to provide structural integrity or extruded as filaments as use in other structures, for example, sliver, staple, and tow.

The use of thermoplastic polymers to form fibers and fabrics as well as a variety of shaped objects is well known. Common thermoplastic polymers for these applications have been polyolefins, particularly polyethylene and polypropylene. Polyolefins as a class tend to be hydrophobic materials and as such are relatively nonwetable by water, making fibers or fabrics made from these materials less than completely suitable for applications which call for wettability. Such applications are as absorbent products like diapers, feminine hygiene products, incontinence products and bandages which generally employ materials which exhibit hydrophilic characteristics. Despite their hydrophobic character, however, polyolefins continue to be the most common thermoplastic fiber forming polymer because of their low cost. As a result, a number of attempts have been made to provide a polyolefin fiber and fabric made therefrom which are hydrophilic and wettable.

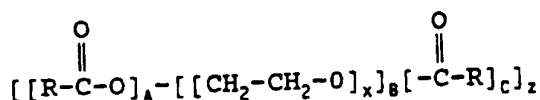
In the applications mentioned above as well as others, the product, for example a diaper, may receive multiple liquid insults before disposal. It is important, therefore, that wettability, once imparted to a polyolefin, be durable. A wettable polyolefin in which the property of wettability was substantially reduced or even removed completely after one or even two wettings would probably be of very limited utility for applications with multiple

insults. Durable wettability is defined therefore as the ability to become wet after at least three prior wettings.

It is an object of this invention to provide a polyolefin fabric and fiber having durable wettability and which is relatively simple in execution, i.e., requiring no extra-ordinary post-treatment of the fibers. It is a further object of this invention to provide a polyolefin fiber having durable wettability.

#### SUMMARY OF THE INVENTION

The objects of the invention are realized by a nonwoven fabric having durable wettability comprising fibers formed from polyolefin blended with hydrophilic additives of the formula;



20

wherein x is an integer from 1 to 15, R is an alkane or alkene with up to 18 carbon atoms, A, B, and C are integers equal to or greater than one and may be arranged in any order, z is an integer equal to or greater than one, and wherein the fibers which have been formed are polyolefin provided with hydrophilic additives prior to fiberization.

#### DETAILED DESCRIPTION OF THE INVENTION

30

As used herein the term "nonwoven fabric or web" means a web having a structure of individual filaments, fibers or threads which are interlaid, but not in a regular manner such as in knitting and weaving. Nonwoven fabrics or webs have been formed from many processes such as for example, meltblowing processes, spunbonding processes, and bonded carded web processes.

35

As used herein the term "meltblown fibers" means fibers formed by extruding a molten thermoplastic material through

a plurality of fine, usually circular, die capillaries as molten threads or filaments into a high velocity gas (e.g. air) stream which attenuates the filaments of molten thermoplastic material to reduce their diameter, which may  
5 be to microfiber diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a collecting surface to form a web of disbursed meltblown fibers. Such a process is disclosed, for example, in U.S. Patent no. 3,849,241 to Butin.

10 As used herein the term "spunbonded fibers" refers to small diameter fibers which are formed or "spun" by extruding molten thermoplastic material as filaments from a plurality of fine, usually circular capillaries of a spinnerette with the diameter of the extruded filaments  
15 then being rapidly reduced as by, for example, in U.S. Patent no. 4,340,563 to Appel et al., and U.S. Patent no. 3,692,618 to Dorschner et al. The "bonding" step of spunbonding is usually accomplished thermally by passing the spun fabric between the rolls of a heated calender.  
20 Various patterns can be imparted to the fabric by the calender rolls but the principle purpose of bonding is to increase the integrity of the fabric. The bond area in thermal bonding is usually about 15% but may vary widely depending on the desired web properties. Bonding may also  
25 be done by needling, hydroentanglement or other methods known to those skilled in the art though the method used in this invention is preferably thermal calender bonding. The spunbonding process is well known in the art.

As used herein the term "polymer" generally includes but  
30 is not limited to, homopolymers, copolymers, such as for example, block, graft, random and alternating copolymers, terpolymers, etc. and blends and modifications of any of the foregoing. Furthermore, unless otherwise specifically limited, the term "polymer" shall include all possible  
35 geometrical configuration of the material. These configurations include, but are not limited to isotactic, syndiotactic and random symmetries.

Thermoplastic polymers, particularly polyolefins are well known in the art for fabricating shaped articles as well as for fiberization. It is believed that any polyolefin capable of being fiberized is suitable for use in this invention. Examples of suitable polyolefins include homopolymers and copolymers of one or more aliphatic hydrocarbon, including, for example, ethylene, propylene, butenes, butadienes, pentenes, hexenes, heptenes and octenes. The polyolefins may be branched or linear chains and may be of high or low density.

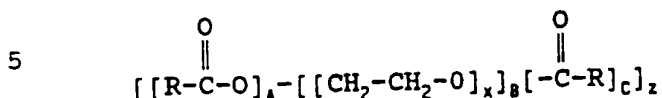
Polyolefins tend to be hydrophobic, making them less desirable for certain applications which require water wettability. In addition, it is especially desirable for such wettability, once imparted to the polyolefin, to be durable. The reason for the desirability of durable wettability is that the products made from these polyolefin fabrics, for example, diapers, may receive multiple liquid insults before being disposed of. Other products in which a durably wettable fabric may find utility are feminine hygiene products, adult incontinence products, wound dressings, bandages and wipers. Wipers may be for industrial use or for home use as countertop or bathroom wipes.

Accordingly, an internal wetting additive may be added to the polyolefin which will produce a polyolefin fiber which is durably wettable.

The internal wetting additive may be added to the polyolefin and compounded in a twin screw extruder in amounts up to 10 weight percent of the blend. Any other method known to those skilled in the art to be effective for the mixing of these components may be used. This mixture may be further blended with neat polyolefin and extruded and fiberized. The fibers or filaments collected to form a web are then bonded, generally thermally, to produce a nonwoven fabric. It has been found that fabrics so produced have unexpectedly durable wettability,

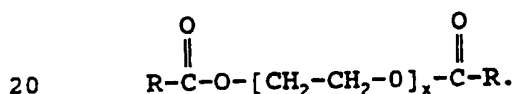
resisting removal of this property upon repeated water washings.

The internal wetting additive is of the formula;



wherein x is an integer from 1 to 15 and R is an alkane or  
10 alkene with up to 18 carbon atoms and A, B, and C are  
integers equal to or greater than one and may be arranged  
in any order and z is an integer equal to or greater than  
one.

A more particular example of the internal wetting  
15 additive is represented by the above formula wherein A, B,  
C and z are equal to one, i.e.;



In actual practice, a sample of such an additive will  
yield molecules having slightly differing values from those  
25 desired for x, A, B, C and z but which will have a  
distribution averaging about the desired values. These  
molecules are generally characterized as di-fatty acid  
esters of polyethylene oxide. The di-fatty acid esters  
were found to be particularly durable when used with  
30 polypropylene.

A specific example of the internal wetting additives  
which is available commercially is DO-400 available from  
PPG Mazer, Inc. of Gurnee, Illinois, a division of PPG  
Industries, Inc., One PPG Place, Pittsburgh, PA, 15272.

35 The internal wetting additive present in the fibers and  
fabric of this invention is "activated" upon heating. It  
is believed, though applicant does not wish to be bound by  
any particular theory, that this activation is a result of  
increased subsurface to surface migration of the additive  
40 caused by heating. Since spunbond and meltblown fabrics

are normally subjected to thermal calendering, no additional processing step is necessary for the fabric of this invention beyond that used for conventional spunbond and meltblown fabric formation. Should a method of bonding  
5 other than thermal calendering be used, however, a heating step would be necessary for activation and such a method would be equivalent to thermal calendering.

Other methods of imparting wettability to polyolefins, while no doubt sufficient for some applications, generally  
10 suffer from a lack of durable wettability. Typical coating operations on polyolefins, for example, result in topical coatings which are easily removed from the fibers with water washing.

The following examples illustrate the superior durable  
15 wettability of the instant invention (Examples 2, 3, 5, & 6 are included for comparison and are not of this invention). The mixtures were generally produced by compounding the ingredients in a 30 or 60 mm twin screw extruder. Any other method known to those skilled in the  
20 art of compounding polymers as effective may also be used. For the Examples, the mixture was produced by mixing polypropylene with each additive at a level of 10% in a twin screw extruder. The resulting polymer mixture was then dry blended with neat polypropylene in order to reach  
25 the percentage of additive mentioned in each Example.

The fabrics were spun at 470°F (243°C) at a rate of approximately 0.7 grams/hole/minute. The fabric was bonded by thermal calendering at a pattern roll temperature of 265°F (129°C) using an expanded Hansen Pennings pattern  
30 with a 15% bond area as taught in U.S. Patent 3,855,046 to Hansen and Pennings. The final basis weight of the bonded fabric was approximately 1 ounce/square yard (osy).

The additives in the Examples are available commercially from PPG Mazer, Inc. The polyolefin used was Exxon  
35 Chemical Company's PD3445 polypropylene which has a melt flow rate of 35 g/10 min. The results of the Examples are shown in Table 1.



EXAMPLE 1

Spunbond fabric was produced according to the method described above. The fibers from which the fabric was made had 1 weight percent of dioleate ester of polyethylene oxide with an average molecular weight of 400 (DO-400). Upon thermal bonding the fabric became wettable. In order to test the durability of the wettability of this material to washing with water, 1 inch x 6 inch (2.5 cm x 15 cm) strips of the fabric were gently agitated in 500 ml of distilled water for one minute, removed and allowed to air dry. This procedure was repeated until the sample became non-wettable. Wettability was determined by placing five drops (approximately 100 microliters each) of water gently on the fabric. Highly wettable materials were instantly wet by all of the drops. Moderately wettable materials imbibed four of the five water droplets within one minute. Unwettable materials were characterized by having the five water drops remain intact on the surface of the fabric for more than five minutes.

EXAMPLE 2

Spunbond fabric was produced as in Example 1. The fibers from which the fabric was made had 1 weight percent of ethoxylated ester of castor oil (CO-8). Upon thermal bonding the fabric became wettable. The fabric was gently agitated in 500 ml of distilled water for one minute, removed and allowed to air dry. This procedure was repeated until the sample became non-wettable. Wettability was determined in the same manner as in Example 1.

EXAMPLE 3

Spunbond fabric was produced as in Example 1. The fibers from which the fabric was made had 1 weight percent of a 50/50 blend of glycerol mono-oleate ester and ethoxylated nonylphenol (GMO/NP-12) as described in U.S. Patent 4,578,414 to Sawyer. Upon thermal bonding the fabric became wettable. The fabric was gently agitated in 500 ml of distilled water for one minute, removed and allowed to air dry. This procedure was repeated until the sample became non-wettable. Wettability was determined in the same manner as in Example 1.

EXAMPLE 4

Spunbond fabric was produced as in Example 1. The fibers from which the fabric was made had 5 weight percent of dioleate ester of polyethylene oxide (DO-400). Upon thermal bonding the fabric became wettable. The fabric was gently agitated in 500 ml of distilled water for one minute, removed and allowed to air dry. This procedure was repeated until the sample became non-wettable. Wettability was determined in the same manner as in Example 1.

EXAMPLE 5

Spunbond fabric was produced as in Example 1. The fibers from which the fabric was made had 5 weight percent of a 50/50 blend of glycerol mono-oleate ester and ethoxylated nonylphenol (GMO/NP-12) as described in U.S. Patent 4,578,414 to Sawyer. Upon thermal bonding the fabric became wettable. The fabric was gently agitated in 500 ml of distilled water for one minute, removed and allowed to air dry. This procedure was repeated until the sample became non-wettable. Wettability was determined in the same manner as in Example 1.

EXAMPLE 6

Spunbond fabric was produced as in Example 1. The fibers from which the fabric was made had 3 weight percent of MAYPEG 400-ML monolaurate. Upon thermal bonding the fabric became wettable. The fabric was gently agitated in 500 ml of distilled water for one minute, removed and allowed to air dry. This procedure was repeated until the sample became non-wettable. Wettability was determined in the same manner as in Example 1.

TABLE 1

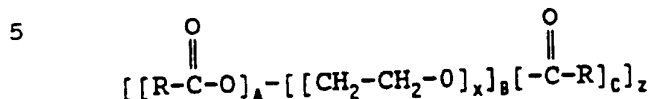
Example	1	2	3	4	5	6
Condition						
as made	W*	W	W	W	W	W
after 1 <sup>st</sup> wash	W	W	NW	W	NW	NW
after 2 <sup>nd</sup> wash	W	NW	NW	W	NW	NW
after 3 <sup>rd</sup> wash	NW	NW	NW	W	NW	NW
after 4 <sup>th</sup> wash	NW	NW	NW	W	NW	NW

\* W Means the fabric was either highly or moderately wettable according to the test procedure described in Example 1, NW means the fabric did not become wet as defined in the test procedure.

The above results clearly show the surprisingly durable wettability of the present invention. At a level of 1 weight percent (Example 1) the fabric made according to this invention had substantially more durable wettability than the fabric of Example 5 which had an additive level of 5%. Example 4, also of a fabric of this invention, had 5 weight percent of the wetting additive and exhibited durable wettability even after the fourth washing.

I claim:

1. A nonwoven fabric having durable wettability comprising fibers formed from polyolefin blended with at least one hydrophilic additive of the formula;



10 wherein x is an integer from 1 to 15, R is selected from the group consisting of alkanes with up to 18 carbon atoms and alkenes with up to 18 carbon atoms, A, B, and C are integers at least equal to one arranged in any order, z is an integer at least equal to one, and wherein said fibers have been formed by providing said at least one hydrophilic  
15 additive to said polyolefin prior to fiberization.

2. The nonwoven fabric of claim 1 wherein said hydrophilic additive formula has a value for x of from 7 to 11 and A, B, C and z are equal to 1.

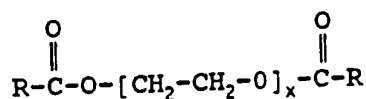
3. The nonwoven fabric of claim 1 wherein said polyolefin is selected from the group consisting of polyethylene and polypropylene.

4. The nonwoven fabric of claim 1 wherein said hydrophilic additive is present in an amount from about 0.1 weight percent to about 10 weight percent.

5. The nonwoven fabric of claim 1 wherein said hydrophilic additive is present in an amount of about 5 weight percent.

6. The nonwoven fabric of claim 1 which is present in an absorbent product selected from the group consisting of diapers, feminine hygiene products, adult incontinence products, wound dressings, bandages and wipers.

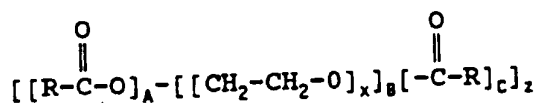
7. A nonwoven fabric having durable wettability comprising fibers wherein one of the components is formed from polyolefin blended with hydrophilic additives of the formula;



wherein x is an integer from 7 to 11 and R is an alkane with up to 18 carbon atoms, in an amount of about 5 weight percent and wherein said fibers have been formed by providing said hydrophilic additives to said polyolefin prior to fiberization.

8. A method of producing a nonwoven fabric having durable wettability which comprises:

(a) forming a blend by thoroughly mixing a polyolefin with at least one hydrophilic additive of the formula;



wherein x is an integer from 1 to 15 and R is selected from the group consisting of alkanes with up to 18 carbon atoms and alkenes with up to 18 carbon atoms, A, B, and C are integers at least equal to one arranged in any order, z is an integer at least equal to one;

(b) melting said blend;

(c) fiberizing said blend by extrusion through a plurality of fine capillaries;

(d) depositing said fiberized blend on a collecting surface to form a randomly dispersed web; and,

(e) thermally bonding said fiberized blend web.

9. The method of claim 8 wherein A, B, C and z are equal to one.

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT, JS 94/11732A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 D04H1/42

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 D04H D01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP,A,0 491 293 (KIMBERLY-CLARK CORPORATION) 24 June 1992 see whole document ---	1,3,6-8
Y	EP,A,0 152 883 (THE DOW CHEMICAL COMPANY) 28 August 1985 cited in the application see claim 1; example 1 ---	1,3,6-8
A	DATABASE WPI Section Ch, Week 9014, Derwent Publications Ltd., London, GB; Class A94, AN 90-103315 & JP,A,2 053 950 (KURARAY KK) 22 February 1990 see abstract -----	1,3,6

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&amp;" document member of the same patent family

Date of the actual completion of the international search

16 February 1995

Date of mailing of the international search report

03.03.95

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax (+31-70) 340-3016

Authorized officer

V Beurden-Hopkins, S

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/JS 94/11732

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0491293	24-06-92	US-A- 5200130	06-04-93
		AU-B- 641827	30-09-93
		AU-A- 8816891	18-06-92
		JP-A- 4314742	05-11-92
		US-A- 5258221	02-11-93
EP-A-0152883	28-08-85	AU-B- 557204	11-12-86
		AU-A- 3857385	22-08-85
		CA-A- 1261526	26-09-89
		JP-C- 1591506	30-11-90
		JP-B- 2014444	09-04-90
		JP-A- 60194113	02-10-85
		US-A- 4578414	25-03-86